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ABSTRACT

There is both less and more to mastery learning (ML) than meets the eye. Less because mastery learning is not based on a model of school learning, and more because it is the most optimistic statement we have about the power of education. The notions of setting achievement standards and letting time for completion vary, of using criterion referenced tests, of the motivational value of success, of individualizing instruction according to student traits, and of formative evaluation and feedback are not unique to ML but what is unique to ML is the hypothesis that using these notions together can transform slow learners into faster learners. Recent state laws require mastery or minimum standards, but not that ML strategies be adopted. Questions should be answered about three aspects of ML: cost efficiency, equity, and externalities. ML will be characterized by rising costs as the target mastery level is raised. Equity refers to fairness in the distribution of resources to students, since ML calls for allocation of resources in roughly inverse proportion to prior achievement. An externality is a consequence of an action which affects others not party to the action. Marginal externalities should equal or exceed the marignal cost of obtaining them. (Author/CTM)

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THE PUBLIC ECONOMICS OF MASTERY LEARNING

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Introduction

There is both less and more to "mastery learning" than meets the eye.[1] "Less," because contrary to the words of its advocates, mastery learning (ML) is not based on a model of school learning, nor is it a theory of school learning. "More," because its most important claim raises ML from the status of an instructional strategy to the most optimistic statement we have about the power of education.

Mastery learning advocates cite John Carroll's "Model of School Learning" (1963) as the basis for subsequent ML formulations (Block and Burns, 1976, p. 4; Bloom, 1968; Bloom, 1976, p. 4). What is curious about Carroll's model is that there is nothing about school in it. It is a model pertaining to learning from instruction, but it is framed entirely at the level of the individual student. None of the institutional characteristics of schooling enter the model at all. The most familiar feature of schools, the organization and instruction of groups of learners, is absent from the model. The model is silent with respect to the educative or miseducative effects of authority structures or other institutional features. It is silent, too, with respect to the political or social functions of schools and the ways these impinge on

[1]The reader is assumed to be familiar with "mastery learning" as described by Bloom (1968), Block (1971), Block and Burns (1976) and Bloom (1976).

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student learning. In short, Carroll devised a model of individual learning from instruction which, however insightful and useful it may be in that regard, is not the more comprehensive model of school learning its label suggests.

This suggestion of something that is not there is repeated by Professor Bloom in the title of his recent book, Human Characteristics and School Learning (1976). This book builds upon and extends mastery learning concepts first proposed by Bloom in 1968. Bloom indicates that "the intent of this book is to develop a theory of school learning which will enable us to predict, to explain, and to modify individual differences in school learning" (p. 12). Once again, however, the key concepts are in terms of individuals. The paradigm is that of an excellent tutor and a single student (p. 112). Although Bloom recognizes the qualitative difference between one-to-one tutoring and the management of group instruction (p. 114), the book provides no link from one to the other. There is no theory to explain why some learning is assigned to the schooling context, and other learning is not. Nor is there any explanation by way of the theory why the present organization and conduct of instruction in schools differs from the idealized mastery learning model. Bloom does address the problem of individual differences in learning, but his analysis does not really pertain to any institutional problems that are specifically "school" in nature, and it applies equally well to instruction at home or at work.

On the other hand, there is more to ML than first meets the eye, because in the seemingly simple guise of an approach or strategy of instruction, ML makes a claim for the power of education which could

have far reaching consequences. This is the claim, or, less assertively, the hypothesis, that ML can reduce the variation in the rate of cognitive learning among students by increasing the speed of previously "slower" learners (Bloom, 1976; Block and Burns, 1976). Indeed, this hypothesis seems to be the principal feature which distinguishes ML from a variety of related instructional precepts. The notions of setting achievement standards and letting time to completion vary, of using criterion-referenced rather than norm-referenced tests, of the motivational value of success in learning, of the individualization of instruction according to student traits, of formative evaluation and feedback for error correction, are none of them unique to ML, and indeed no claim for them as unique ML concepts is made in the literature. What is unique to ML, I think, apart from the logic and eloquence with which its advocates tie the above elements together, is the hypothesis that those elements, if handled "sensitively and systematically" (Bloom, 1976, p. 3) can transform slow learners into faster learners.

Were ML able to demonstrate the capability of markedly improving the learning rate of slower learners, it would be a major technological breakthrough for education. It would mean that a key indicator of student ability, rate of learning, was open to modification by school treatment. The notion that schooling may have some effect on ability, as opposed to merely sorting on the basis of ability, is not altogether new, but the expectations raised by ML advocates are certainly among the most optimistic, and most testable, to be heard today.

The evidence on the effects of ML in improving student learning rates is inconclusive. Some studies do seem to indicate a reduction of

variation in student learning time, but the total time spent is greater by from 20% to 80% in ML as compared to non-ML situations (Block and Burns, 1976, pp. 30-31). Carroll (1970) indicates several formidable measurement problems associated with determining rate of learning. The attention in ML research thus far has been directed to improving the rates of the slower learners, the assumption apparently being that faster learners already learn as fast as possible, or at least fast enough. That is, the aim of the ML strategy is to improve the relative learning rate of slower learners, not to increase learning rates generally.[2]

It is not clear how "transferable" such a learning rate increase is expected to be. ML studies thus far have looked at learning rates within particular subjects under mastery instruction, but have not examined the effect of mastery in one subject or skill on the rate of learning another. The benefits of a transferable increase in learning rate would presumably be greater than those of an increase in any one subject. I will return to this point below.

The purpose of these introductory remarks has been to set the stage for the remainder of this paper, in which I will provide some of the analysis needed to determine the suitability of providing a mastery approach in specific school settings. Because ML is not in fact based on a theory of school learning, it does not answer such questions as when, and in what subjects, should ML be employed? These questions must be answered by appeal to additional considerations besides those contained in the ML formulation itself. The motivation for this paper stems from

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[2]Bloom specifically rejects the concept of "holding back" faster learners, however (1976, p. 215).

recognition of increasing interest on the part of legislatures and state boards of education in minimum educational standards. At least 25 states now have, or are considering, laws or regulations which require students to demonstrate some specified level of competence or mastery according to one or more criteria as a condition of promotion or graduation. This development has a number of implications, one of which may be the fostering of environments favoring the adoption and implementation of mastery learning.

A law requiring that some level of mastery or minimum standard be met need not specify that "mastery learning" instruction be adopted. Likewise, a teacher or board of education can provide ML instruction for students in the absence of legislation. But efforts by school persons to conform to such legislation will inevitably be informed by the literature on mastery learning, and likely will involve some efforts to adopt mastery strategies. And the adoption of ML by a teacher or a board may, from the student's point of view, be as much a requirement as if it were law. This paper analyzes the public interest in such directly or indirectly mandated mastery learning in terms of certain economic concepts. With one or two exceptions, this paper gives no further attention to whether or not ML strategies "work." The promise of ML and the possibility that it may help meet minimum standards and avoid educational malpractice suits increases the likelihood of its adoption whether it works or not, at least in the near term. Moreover, ML has certain specific organizational and resource allocation implications which, to the degree they are or are not met, may seriously color judgements about ML effectiveness.

Three Criteria: Efficiency, Equity, Externalities

I will discuss the decision to adopt ML under three rubrics: efficiency, equity, and externalities. The last, externalities, is in economics a special case under the first, efficiency, but the points to be raised here are sufficiently different that I have separated them for the sake of discussion. The second rubric, equity, has no peculiarly economic definition, but can scarcely be omitted from any discussion of public resource allocation. The points raised in each section will be presented in so far as possible as criteria for the selection of schooling topics suitable for mandated standards which might be met by ML instructional approaches.

Efficiency

If later learning depends on or is facilitated by earlier learning, then a case might be made on grounds of educational efficiency for using ML technology in the early stages of schooling, so as to promote more rapid or complete learning later on. There is a widespread presumption in education that the rate and extent of later learning depends on mastery of fundamentals, though the exact specification of what is fundamental is not the same from subject to subject.

It is necessary to say that a case might be made for ML, because even if we were able to agree on the specification of prerequisites to be mastered, certain difficulties would remain in the way of a decision regarding mastery learning on grounds of efficiency. Consider the possibility that "mastery of fundamentals" (or mastery of any subject) is not a single condition one either meets or does not, but rather admits of

degrees. For example, has a person mastered spelling only if he never misspells a word, or can he have mastered spelling if he seldom misspells? Seldom is a matter of degree. This example is perhaps over-simple, but illustrates the point that while a person can or cannot spell a given word, "good spelling" is a matter of degree based on a universe of behaviors. The universe of possible behaviors is larger and perhaps more complex for other subjects, such as reading and arithmetic problem-solving, which might be candidates for status as "fundamentals" or "basics."

This being the case, what level or degree of mastery will be chosen? The answer is, ideally, that level of mastery which costs no more to attain than the value of later learning benefits it confers. The actual measurement and calculation of such costs and benefits appears difficult, if not impossible, but certain observations can be made:

First, ML will be characterized by rising costs as the target mastery level is raised. The shape of this cost curve (i.e., whether marginal costs are rising or falling, and at what rate) is difficult to predict, however. The evidence on increasing learning efficiency under ML cited by Block and Burns (1976) appears to involve only compaisons with non-mastery conditions, not comparisons among different levels of mastery.[3] Moreover, ML studies in general do not provide data on the cost of materials preparation and process coordination. ML is a relatively high-cost technology, requiring the development of formative and summative criterion-referenced tests, and detailed alternative study materials.

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[3]Evidence in the micro-study I conducted is that cost in student time and study materials is approximately linearly related to level of mastery. See Garner, 1973.

Moreover, these materials must be provided to students at the correct times in correct combinations. The result is that ML instruction has high information and coordination costs when viewed as a teaching technology.[4]

Second, because of the additional time requirements, the higher the mastery levels are set and the larger the number of subjects with required mastery levels, the higher the opportunity cost to students in terms of foregone play, foregone pay, or foregone learning of other subjects (Thomas, 1971). Apart from the empirical question of the extent to which such foregone opportunities can be balanced by increased learning later on due to achieving earlier mastery, it is not obvious that all students or parents would select the mastery time allocation requirements if given a choice.[5] Some persons might prefer variety through exposure to several subjects rather than "mastery" of a limited number. Interference with such preferences presumably should be based only on strong evidence of learning efficiency (and of externalities, see below).

Thus the question as to what levels of mastery should be prescribed, and in which subjects, is not readily answered simply by appeal to the notion of improved educational efficiency due to the mastery of fundamentals. Later efficiency can only be obtained at the cost of present opportunities and instructional resources. The question might be rephrased as, "How much additional mastery, beyond present levels, are we

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[4]See Levin, 1974. In addition, the adoption of ML may require considerable adaptation in school organization. See Spady, 1974.

[5]In particular, students with a high time discount rate might not.

willing to pay for?" In view of the uncertainty of actual learning efficiency results attributable to ML, and its present relatively high costs in time, effort, and materials, few subjects are likely to justify public endorsement and requirement of ML on these grounds in the near future.[6]

Equity

Equity here refers to fairness in the distribution of resources, or of access to resources. If we are to discriminate among persons in the provision of services, then such discrimination should be such as to be perceived as proper and fair, not arbitrary or unjust. The past decade has seen considerable interest in equity in school finance in the United States. Despite the rhetoric of equal educational opportunity surrounding the "new school finance," most of that debate and litigation has been focused more on equity for taxpayers than on equity in the educational services actually provided (Berke, 1974).

The implications of ML with respect to resource allocation are straightforward: mastery learning calls for allocation of resources in roughly inverse proportion to prior achievement. The goal of such differential allocations is to produce equal (or more nearly equal) outcomes. But in what areas and according to what reasons is there a public interest in assuring such equal outcomes by providing ML instruction on grounds of equity?

A two-stage rationale might serve to explain the adoption of ML as a means of assuring equal opportunity. If some degree of competence in

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[6]Discussion of the efficiency of ML vis a vis other instructional approaches will be found in Levin (1974).

a subject influences the choices a student can make or the opportunities open to him subsequently in school or in the world of work, an argument might be made that the school should employ the ML model in that subject in order to assure that no student be prematurely or arbitrarily foreclosed from such options. This is a two-stage rationale because the adoption of mastery learning itself is a committment to the unequal allocation of resources, and thus might appear to be at odds with the concept of equal access. The appropriate condition is that attainment in the ML subject must be a prerequisite for access to important subsequent opportunities.

A few examples may help make this clear. A student who has not achieved well in elementary school mathematics may not be allowed to take Freshman Algebra in high school. Without algebra, the student may not be permitted to take geometry or the more advanced topics of 11th and 12th grade. The school may have a nominal policy permitting students to take algebra after a year of "pre-algebra," but there may be some stigma attached to that, and at any rate the student is now "behind" one year. In the case of reading and writing skills, poor reading skills may exclude a student from classes which are in effect college preparatory. Students in a college prep class are not for that reason obliged to go to college; they may go or not, as they choose. But students denied access to college prep classes do not have the same choice, or at least not in the same circumstances. Similar remarks could be made about any course which is important in the subsequent grouping, labeling, or "tracking" of the student.

Certain skills and subjects serve as gateways to future academic

and life opportunities. These skills and subject areas are candidates for the adoption of a mastery learning approach as a matter of schooling policy. That is, if the degree of success or failure in a course or skill determines the student's access to subsequent courses or an entire set of experiences, then there may be a case for attempting to assure later access (when the student is older and perhaps better able to choose) by providing high levels of mastery for all of the prerequisite skills. Thus, mastery learning would be consistent with approaches to equity which stress differential application of resources as a means to equality of some characteristic as an end; in this case, equality of attainment and therefore of opportunities dependent on such attainment.

Externalities

The third concept I suggest as relevant in decisions about whether or not to adopt mastery learning is that of externalities. An externality is a consequence of an action (or inaction) which affects others not party to the action. We have been made familiar with externalities by the debates over air and water pollution. The industrial firm that discharges wastes into a river may cause unpleasantness or hardship on others downstream who have nothing to do with that plant or its products. The smoker who lights up at the table next to yours in a restaurant may by his action spoil your enjoyment of your meal. Although you may be able to persuade the smoker to put out his cigarette, there is probably little you as an individual can do to persuade the firm to clean up the river.

Not all externalities are negative ones; some may bring increased

enjoyment or satisfaction. A beautiful home may enhance a neighborhood, for example, or the tearing-down of a building may improve the view from the apartments in another. A more significant example is innoculation against disease, which by reducing incidence of the disease confers benefits on those not innoculated. Even if you would gladly pay to purchase these benefits, whom would you pay? As there is no market for buying and selling such benefits, the government usually plays a role in providing, or discouraging, important externalities.

The existence of large positive externalities is often cited as a justification for government intervention in education. That is, aside from any benefits individuals receive from schooling, there are benefits conferred on society as a whole, including people who do not go to school and people with no children in school. Typical of such benefits usually cited are: a more productive and flexible work force; the encouragement of lawful behavior; political stability as a result of an informed electorate; and several other such global effects (Blaug, 1970). These benefits might be lost or seriously reduced if not enough people went to school long enough, or if too many persons studied the "wrong" things (too much art, perhaps, and not enough U.S. history). But there is no market in which an individual can express his preference for other persons to go to school. Thus, the role of government is to obtain these externalities by means of school policies.

Strictly speaking, compulsory education laws and minimum standards enforcement would be all the government need do to obtain these externalities, but in the U.S. and most countries the government also operates a tax-subsidized schooling system.

The current interest in legislatures and the popular press with declining test scores and the need for new or vigorously enforced minimum standards is a reasonably clear-cut case of public concern about maintaining the proper level of (real or imagined) positive externalities from schooling (see Spady and Mitchell, 1977).

The desire to obtain improved performance with respect to minimum standards by raising the minimum, and by increasing the proportion of students attaining or surpassing the minimum, fits well within the ML model of raising mean student performance while simultaneously reducing the variation in performance. The problem in the present case is to identify those subject or skill areas which are amenable to ML instruction and which will yield high marginal externalities. (Marginal externalities are those additional externalities realized as a result of the ML instruction, above those already realized from current instruction.) The value of the marginal externalities must equal or exceed the marginal cost of obtaining them, i.e., the cost of the ML instruction, if there is to be a net gain to society.

The evaluation of the externalities problem is thus similar in form to the educational efficiency problem, except that here we are concerned about benefits conferred on others, and there the concern was benefits to the individual (and economy within the system). In the present case, however, estimation of the marginal benefits is a good deal harder because of their diffuse and often intangible nature. Actual measurement of marginal benefits may not get beyond scores on local or state "competency" tests, which are of course only proxies of unknown validity for certain desired benefits. The scope of these tests will very likely define

the range of skills and subjects considered to have high marginal externalities associated with performance. The subjects which are amenable to ML instruction can then be selected from among those. Improvements in test results in those subject or skill areas would then have to be weighed against the requisite cost of the ML instruction.

Discussion and Conclusion

This paper began with the observation that mastery learning theory is not a theory of school learning in the sense of indicating what learning is likely to be assigned to schools, or how that learning is affected by organizational or social factors which impinge on schools. I then discussed three criteria which might serve to link mastery learning with specific school subjects and, moreover, to degrees of mastery of those subjects.

The school subjects and skills which emerge as potentially appropriate for treatment by ML instruction as a matter of school policy are those which deal with fundamental and widely applicable skills. In the case of the efficiency criterion, these subjects and skills are nominated because the educational efficiency gains are most likely to outweigh the higher costs of ML instruction. The equity criterion suggests a similar conclusion, though perhaps with more latitude, because in this case particular subjects or skills may serve as access skills for subsequent academic opportunities even if not of a generally applicable nature (though they might be viewed as "fundamental" to further progress along one or another academic line). Finally, the externalities criterion

nominates skills and subjects with high marginal benefits for society. Legislatures and state boards of education seem to be deciding in increasing numbers that these are "basic skills" in such areas as arithmetic computation, reading, and communication.

The considerations raised in this paper suggest that compulsory or mandated adoption of mastery learning can be justified on economic grounds only where there are strong arguments for (1) efficiency in subsequent learning; (2) public committment to equity in subsequent schooling and life opportunities; or (3) high levels of positive externalities. These imply that mastery learning is indicated as policy only in "basic skill" areas, though a precise definition of that term was not attempted. In all other cases, mastery learning is probably not defensible as mandated policy, although it would not be precluded as an optional instructional strategy on a voluntary basis.

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